

MicroTurbines



***What they are
and
how they're used***

US DOE DER Road Shows: May 2003



What is a microturbine and what does it do?

- *A microturbine is a turbine engine-generator, typically sized 250 kW or less*
- *Microturbines can efficiently supplement energy use at the point of use*
- *Creates electricity and heat*
 - *Similar to installing a furnace, boiler, backup genset or chiller*
- *About 3,000 microturbines have been shipped worldwide*
- *Most (>2,500) are made by a USA-based manufacturer, but others are made by firms headquartered in Bermuda, the UK and Sweden.*



An array of 8 kerosene-fueled microturbines at a Japan hospital

What's in it for you?

- ***Reduce your facility's energy costs***
 - *Create energy onsite whenever economically advantageous*
 - *Minimize demand and other utility charges*
- ***Support energy conservation efforts***
- ***Reduce environmental impact***
 - *Offset higher emission utility power*
 - *Reduce flare emissions*
- ***Avoid power outages***
 - *Eliminate production and data losses*
 - *Provide power during emergencies*
 - *Isolate priority loads in problem areas*
- ***Solve facility power problems***
 - *Produce power where needed*
 - *Create power at remote sites*



Microturbines fueled by sewage gas

Microturbine applications

Customer Motivations

<i>Cost Savings</i>	<i>Power Availability</i>	<i>Renewable Power Gen.</i>	<i>Power Quality</i>	<i>Environmental Compliance</i>
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Typical Application Segments

<i>Hotel, Office Buildings, Universities</i>	<i>Health Care, Manufacturing, e-Commerce</i>	<i>Landfill, Livestock, Wastewater</i>	<i>Telecomm, IT, Process Mfg</i>	<i>Petroleum, Process, Materials</i>
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Type of Service

<i>Cogeneration</i>	✓	✓	✓	✓ (CCHP)	✓
<i>Peak Shaving</i>	✓	✓	✓		✓
<i>Prime Power</i>			✓	✓	✓
<i>"Always On" Backup</i>	✓	✓		✓	
<i>Remote Power</i>		✓ (offshore)	✓	✓	

Applications: Cogeneration (“CHP/CCHP”)

Examples of high-efficiency CHP (combined heating and power) and CCHP (combined chilling, heating and power)

✓ **Direct exhaust**

✓ **Hot water**

✓ **Cooling**

Clockwise from top: microturbine exhaust directly fires a 20-ton chiller at Univ. of MD; exhaust from two microturbines fueled by oil flare gas direct heats oil/water separator; microturbines provide power and water/building heating at a YMCA.



Applications: Oilfield flare gas reduction



*Various oilfield
flare/casing gas
installations
onshore and
offshore*

- *Free/low-cost onsite fuel*
- *Generate onsite power from onsite waste or low-value gas*
- *Avoid electrification costs in remote areas*
- *Offset power bills in wired areas*
- *Destroy odors, methane and non-methane compounds*
- *Positive environmental impact*
 - *Avoid emissions penalty charges*
 - *Avoid emission-credit purchases*

Applications: Renewable Biogas

Several bio-fueled microturbine installations



Generate power and heat from flare gas at sewage plants, landfills, livestock farms, food waste, etc.

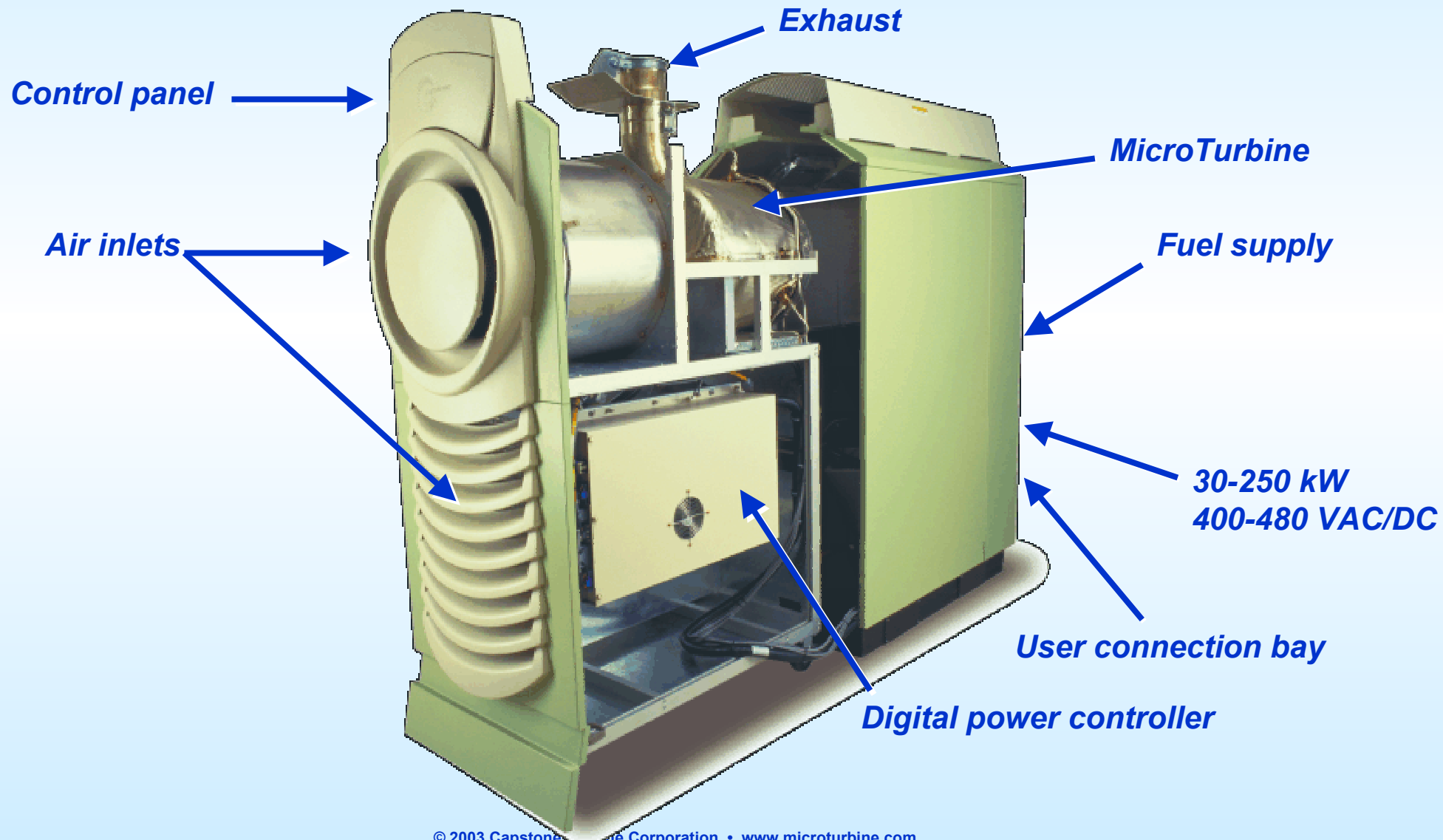


Applications: Standby, peak or prime power

Ensure power certainty in remote areas and in critical business operations

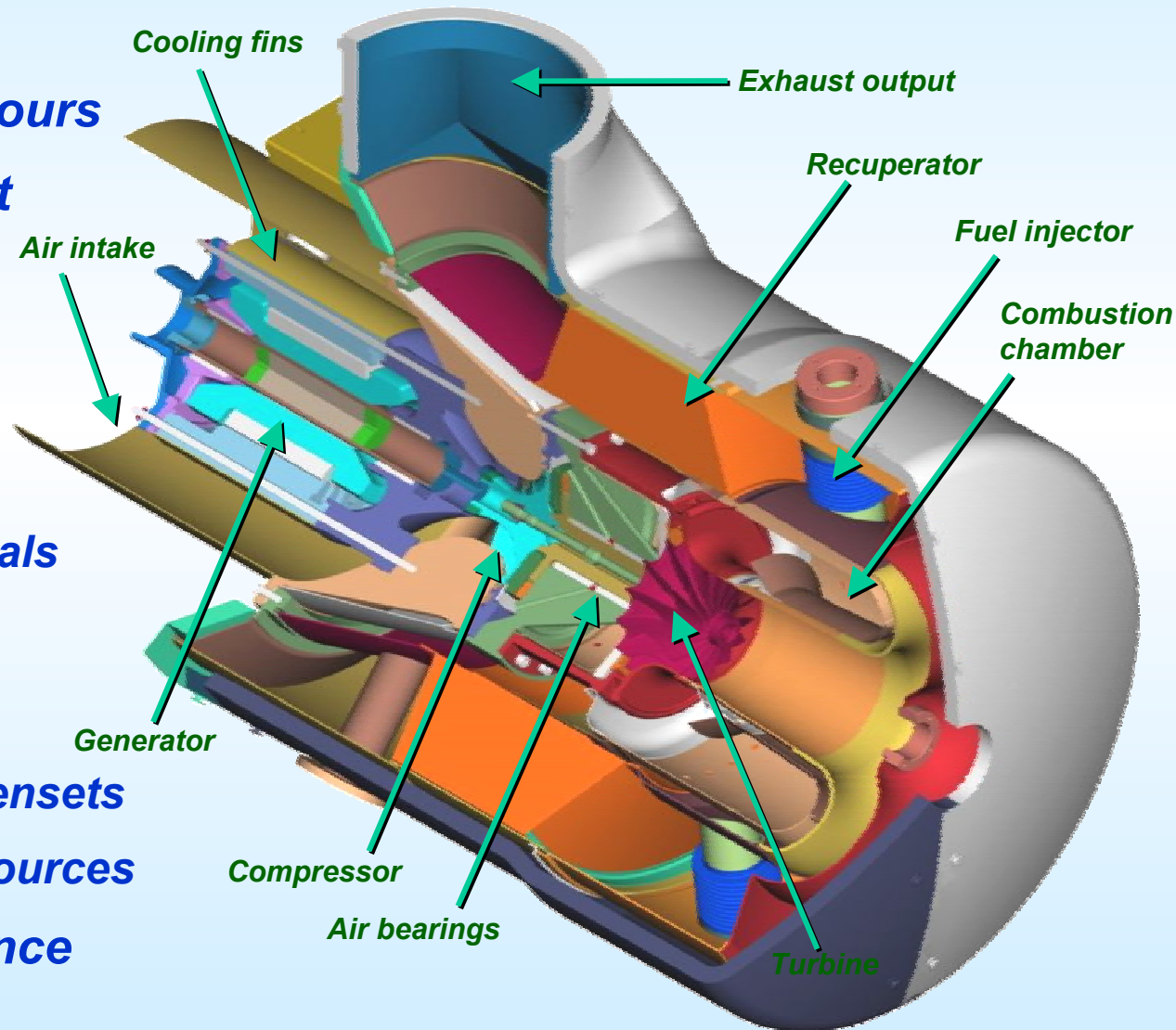


Inside a microturbine



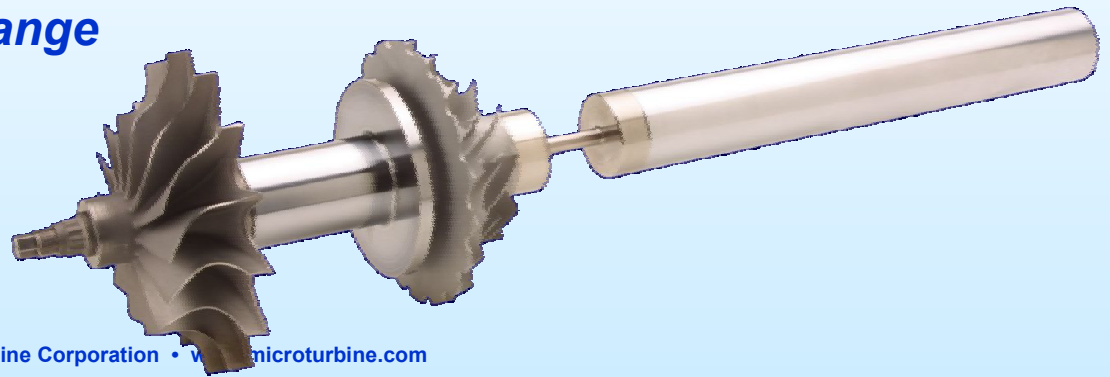
Deep inside a microturbine

- **Millions of fleet operating hours**
- **Few or just one moving part**
- **Some never use coolants, lubricants or other hazmats**
- **Low to ultra-low NO_x**
 - **Without any exhaust cleanup devices or chemicals**
- **Compact and lightweight**
- **Comparably low cost**
 - **More than piston engine gensets**
 - **Much less than other alt. sources**
- **Low-cost, annual maintenance**

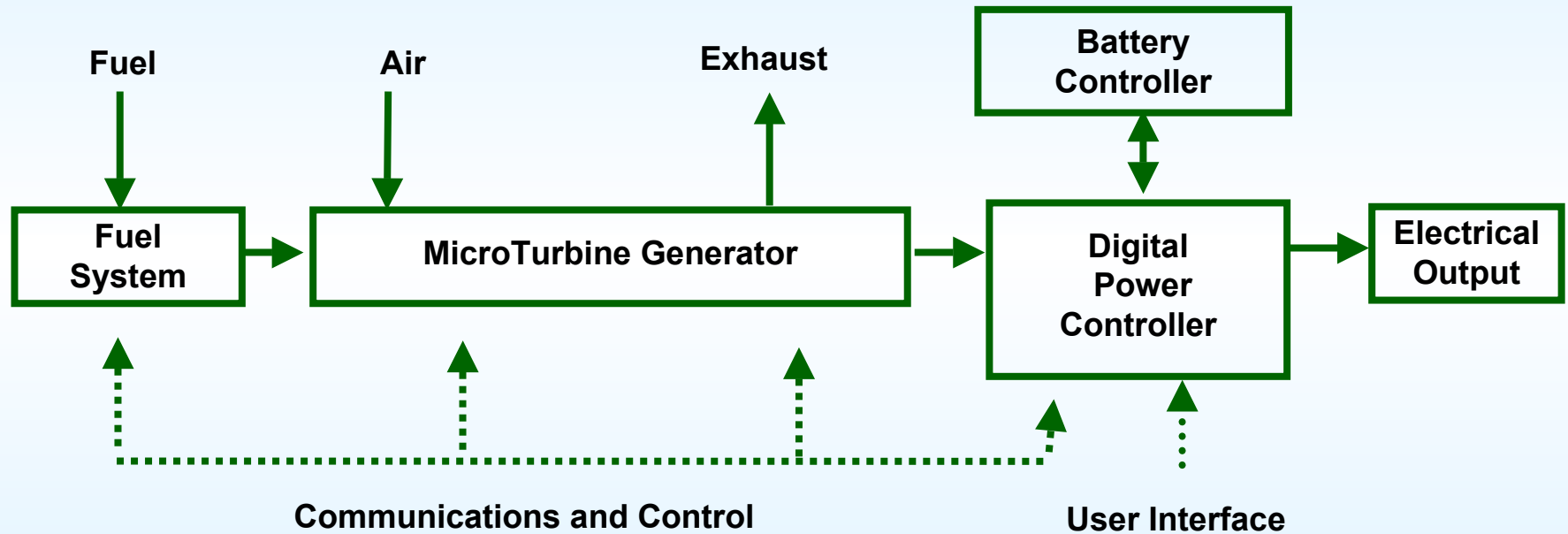


Microturbine intake/exhaust

- **Turbine inlet air flow** 550 SCFM
- **Maximum pressure drop:
(ambient to compressor inlet)** 0.5 inch H_2O
- **Exhaust gas flow** 575 SCFM
(~1100 CFM @ rated conditions)
- **Exhaust gas temperature (max)** 316 °C
(600 °F)
- **Maximum pressure drop
(Back-pressure - Exhaust Flange
to ambient)** 8.0 inch H_2O

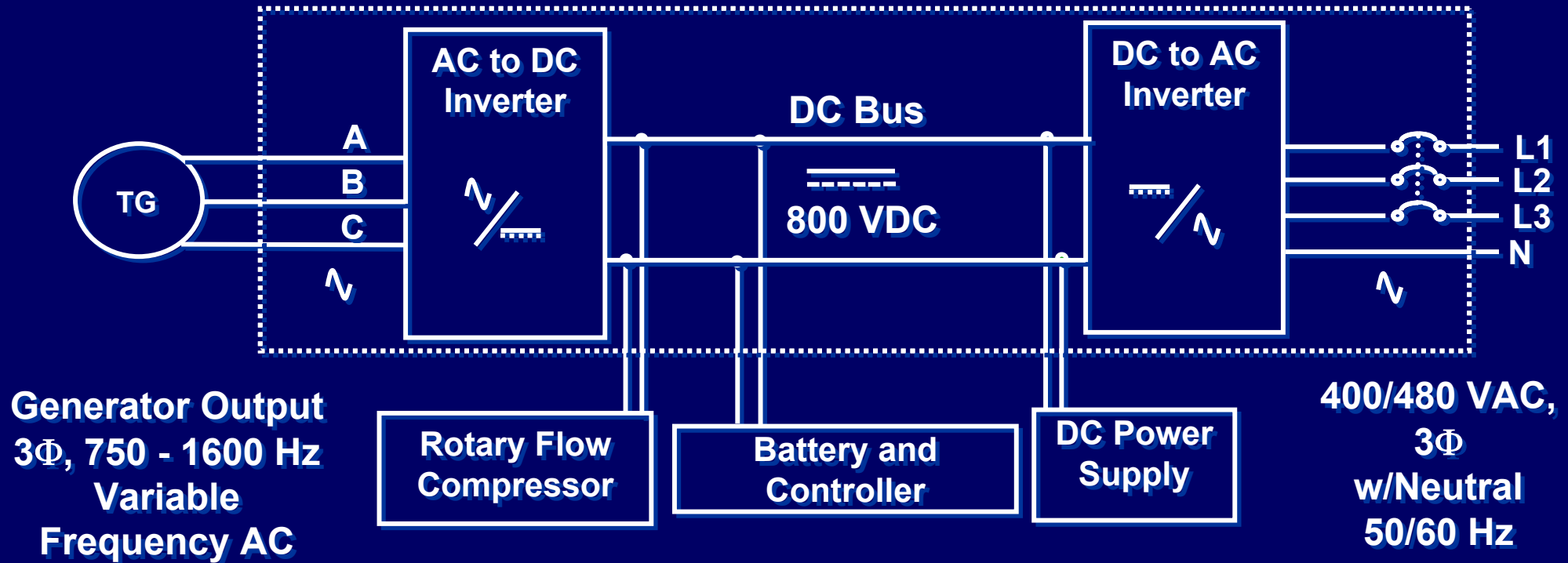


System block diagram

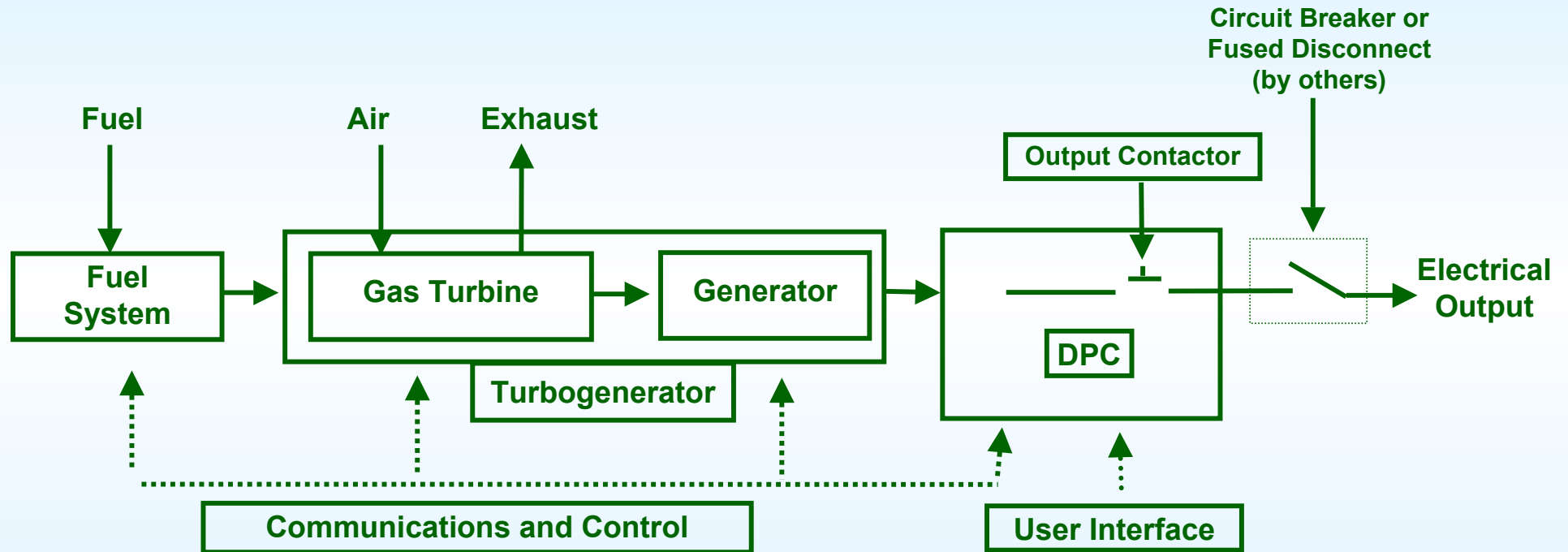


DPC function

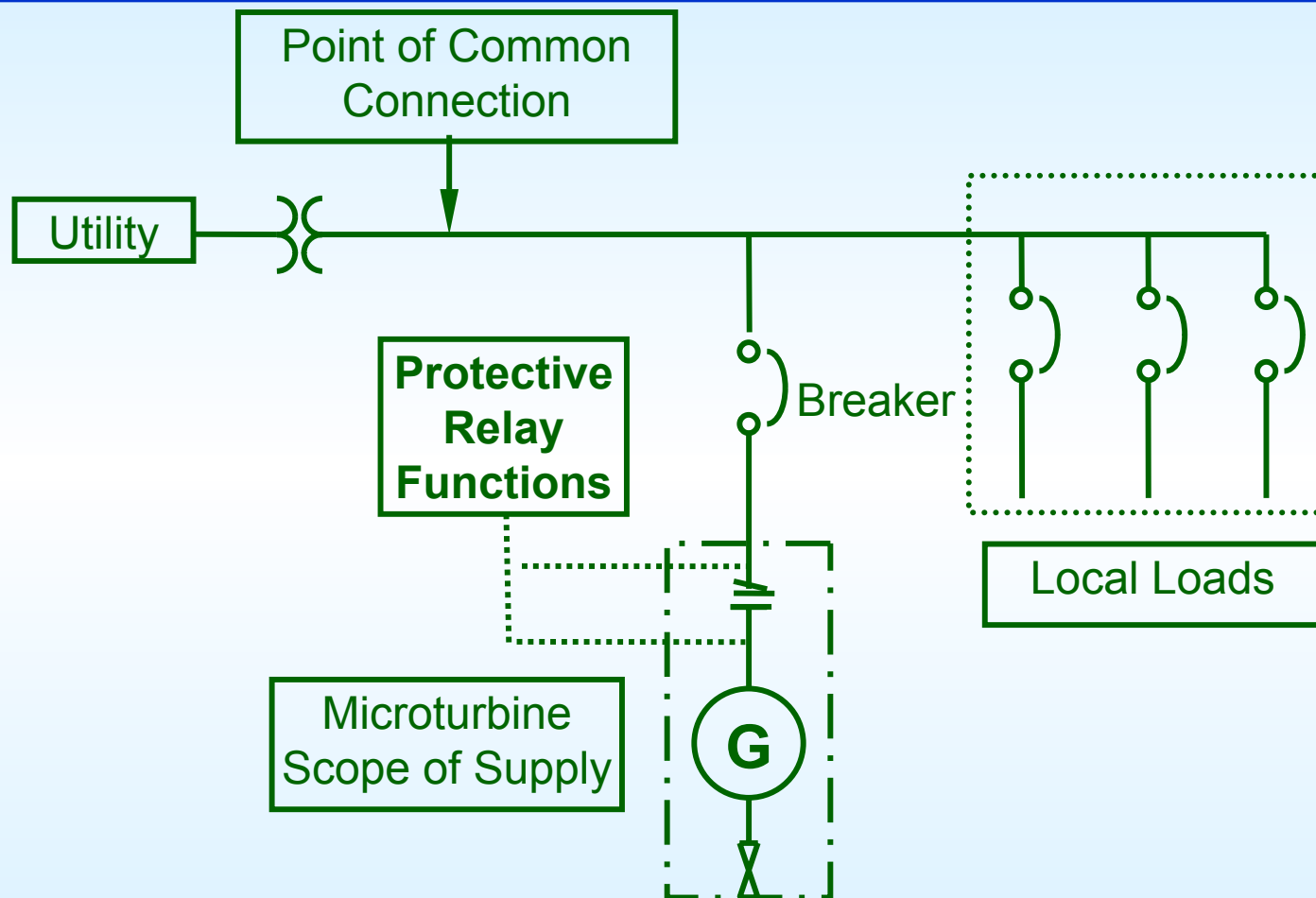
Power Board



Grid isolation



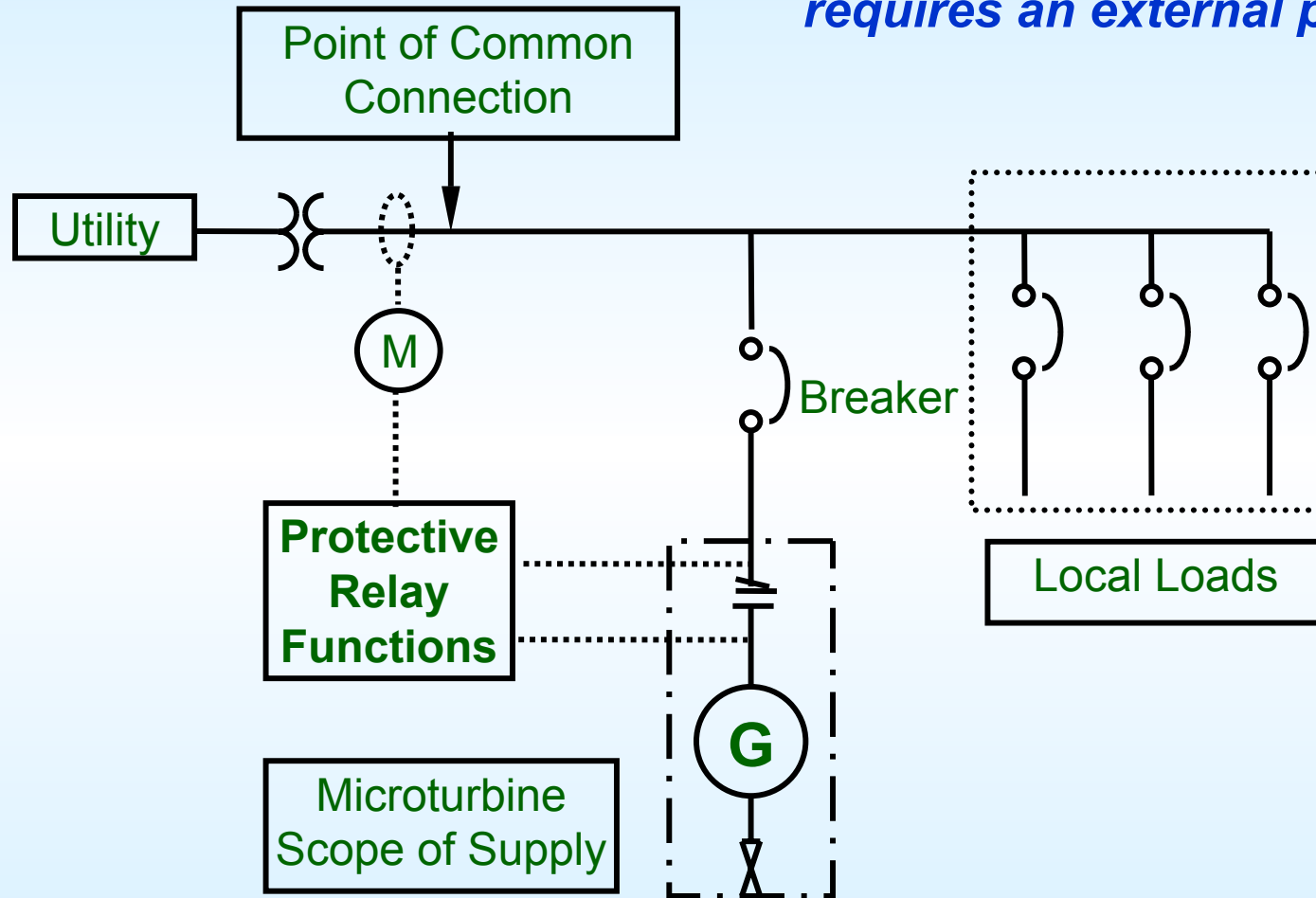
Interconnection using internal relays



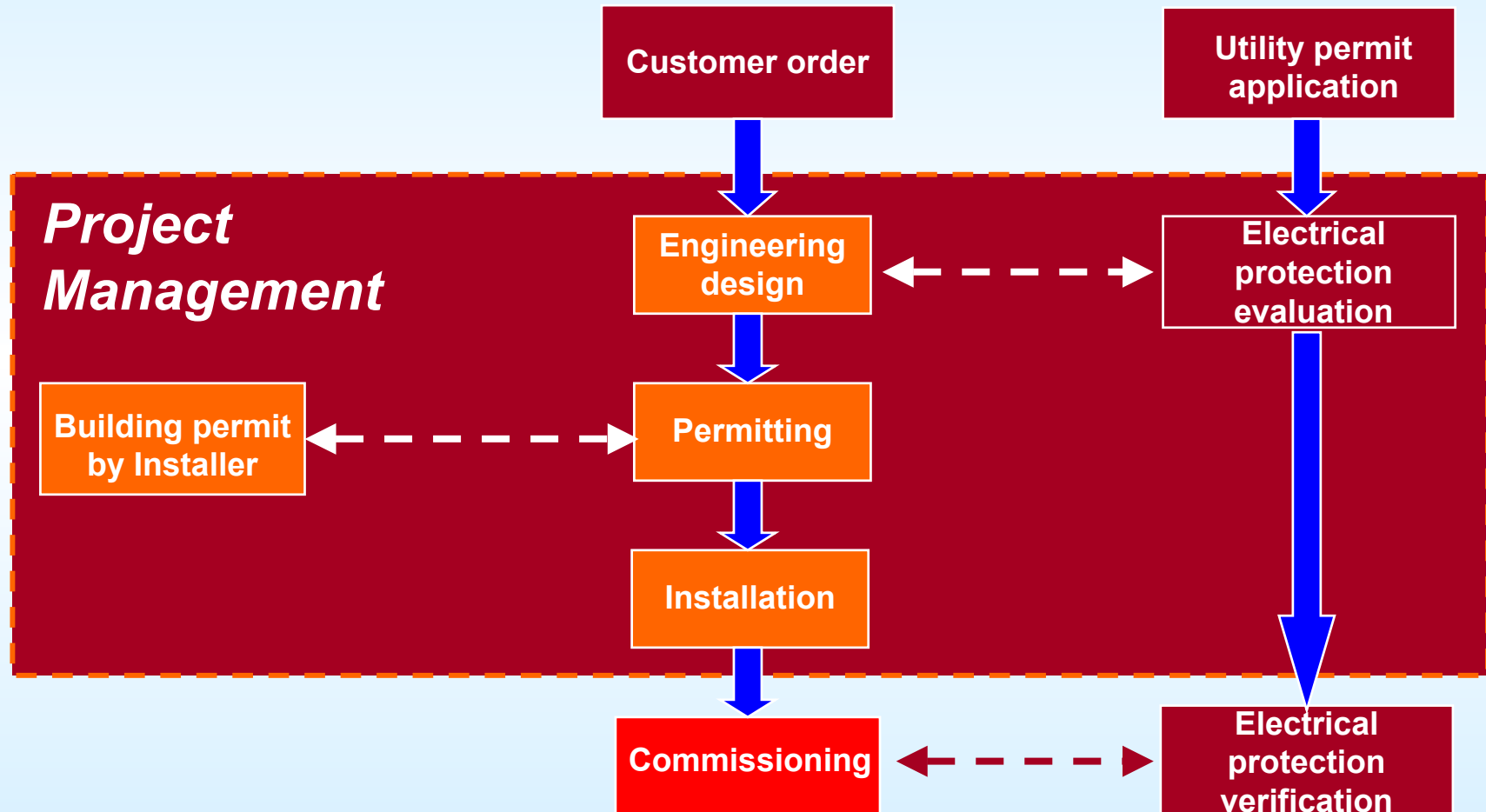
Protective relay functions built into the Capstone MicroTurbine (UL1741) shut down the system if an island condition occurs or if the voltage or frequency fall outside of their programmable setpoints

Reverse power flow protection

requires an external power meter



The installation process



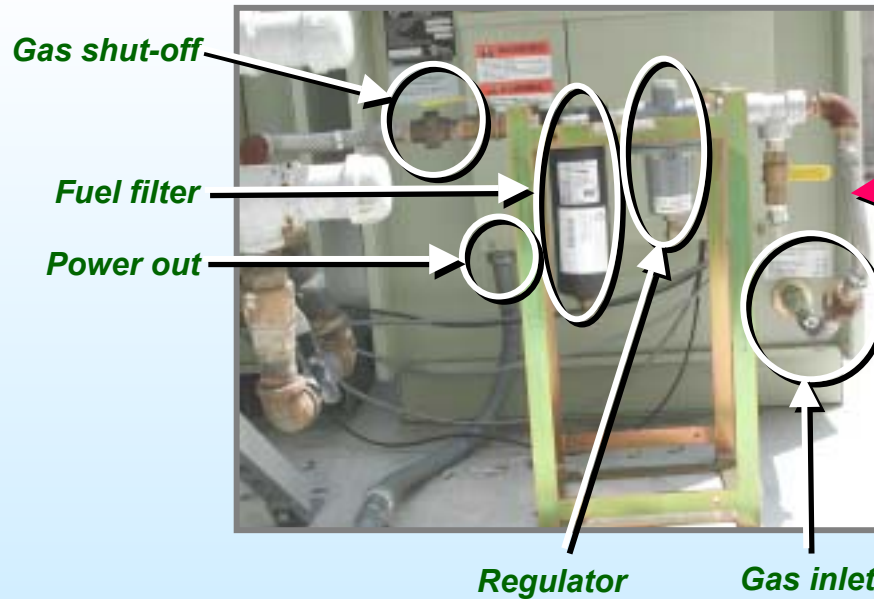
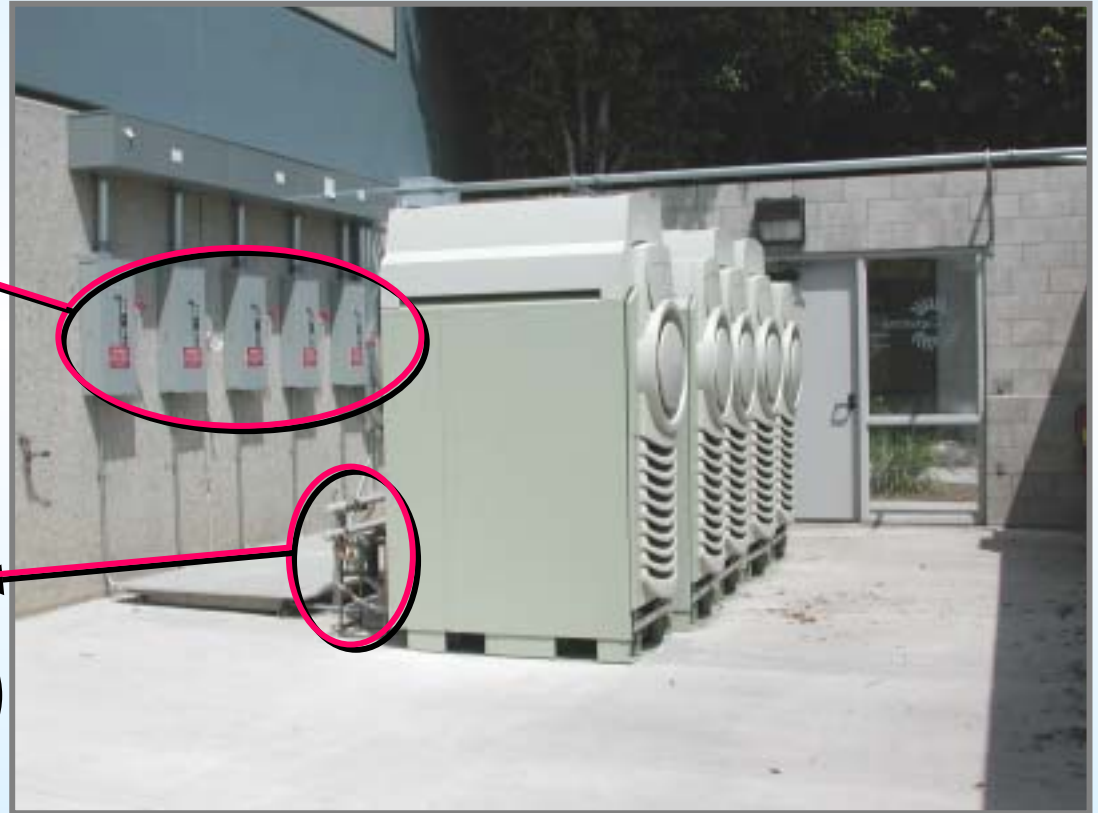
Installation considerations

- **Siting**
 - *Near gas/power hookups?*
 - *Indoor/outdoor/rooftop?*
 - *Proper ventilation?*
- **Service access**
 - *Enough space to perform required maintenance and service tasks?*
- **Public access**
 - *How do I limit public access?*
- **Fuel supply**
 - *Length of piping runs?*
 - *Gas pressure high enough?*
 - *Internal and external compressors available*
- **Power wiring**
 - *Length of power cable runs?*
- **Control wiring**
 - *Length of communications cable?*
- **Intake & exhaust**
 - *Is my intake and exhaust air adequate?*
- **Exhaust heat**
 - *Is there a concern about the exhaust ducting, heat insulation or use?*
- **Regulatory requirements**
 - *Permits: interconnect, air quality, etc.*
 - *Value of UL-Listings to mandated codes*
 - *Which building and fire codes are applicable?*

Typical installation



Fused Disconnect Switch(es)



Regulator

Gas inlet

Applicable standards and codes

- **UL 2200: stationary engine generator assemblies**
- **UL1741: inverter, converters, and controllers for use in independent power systems**
- **UL508C: industrial controllers**
- **ANSI C84.1: electric power systems & equipment voltage ratings (60hz)**
- **ANSI 133.8: turbine sound emissions**
- **NFPA 37: stationary combustion engines**
- **NFPA 54: national fuel gas code**
- **NFPA 70: national electric code**
- **CSA C22.2-100: motors and generators**
- **Major building codes:**
 - **National Building Code**
 - **Uniform Building Code**
 - **Standard Building Code**
- **Air quality permitting standards:**
 - **EPA, CARB, AQMD, DEQ, etc.**
- **Statewide interconnect standards**
 - **NY: PSC standardized interconnect**
 - **CA: Rule 21**
 - **TX: PUC standardized interconnect**
 - **Pending: IEEE P1547 national**

The screenshot shows the California Home Energy Commission website. The header includes 'California Home' and 'Welcome to the California Energy Commission'. The main navigation menu on the left lists various topics: DER Home, Background, DER Equipment, Research Initiatives, Demonstrations, Economics, Incentives / Funding, Markets, Interconnection, Requirements, CA Requirements- Rule 21, IEEE Standard, Equipment, Certification, Working Group, Meeting Minutes, Online Application Form, and Permitting. The main content area is titled 'Distributed Energy Resource guide' and focuses on 'Electrical Interconnection' and 'Equipment Certification'. It states that the following equipment has been tested by a Nationally Recognized Testing Laboratory as having met the Type Testing and Production Testing requirements of California Rule 21. It provides links to detailed information on the tests conducted and the test results, including document links for the Capstone Model 330 and Capstone Model 60. The date 'Wednesday, March 6, 2002' is displayed in the top right corner.

California Home Wednesday, March 6, 2002

Welcome to the **California Energy Commission**

DER Home
Background
DER Equipment
Research Initiatives
Demonstrations
Economics
Incentives / Funding
Markets
Interconnection
Requirements
CA Requirements- Rule 21
IEEE Standard
Equipment
Certification
Working Group
Meeting Minutes
Online Application Form
Permitting

california Distributed Energy Resource guide

Electrical Interconnection

Equipment Certification

The following equipment has been tested by a Nationally Recognized Testing Laboratory as having met the Type Testing and Production Testing requirements of California Rule 21. Please note that the use of Certified Equipment is not a requirement for interconnection in California but intended to simplify the interconnection approval process.

For detailed information on the tests conducted and the test results, please click on the document links below the listed piece of equipment.

Capstone Model 330 30 kw Microturbine Generator

Utility Interconnection Equipment Certification
(4 pages, 13 kilobytes)
[Model 330 Interconnection Testing and Certification Report](#)
(10 pages, 121 kilobytes)
[Electromagnetic Interference Test Report](#)
(18 pages, 1.5 Megabytes)
[Exhibit A - Special Instructions - Manufacturing and Production Tests](#)
(9 pages, 328 kilobytes)
[Model 330 UL 1741 Test Record](#)
(16 pages, 36 kilobytes)

Capstone Model 60 60 kw Microturbine

Utility Interconnection Equipment Certification
(4 pages, 14 kilobytes)
[Model 60 Interconnection Testing and Certification Report](#)
(10 pages, 170 kilobytes)

Making a Difference Today

Microturbines at a detention facility

- ***About 3,000 microturbines have been sold and shipped worldwide for use at a variety of industrial, commercial and municipal facilities. Microturbines are delivering the economic, environmental and community benefits of distributed generation...and are doing so right now.***

